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Automatic constructive appraisal as a candidate cause of emotion

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Abstract

Critics of appraisal theory have difficulty accepting appraisal (with its constructive flavor) as an automatic process, and hence as a potential cause of most emotions. In response, some appraisal theorists have argued that appraisal was never meant as a causal process but as a constituent of emotional experience. Others have argued that appraisal is a causal process, but that it can be either rule-based or associative, and that the associative variant can be automatic. I first propose investigating empirically whether rule-based appraisal can also be automatic. I then propose investigating the automatic nature of constructive (instead of rule-based) appraisal because the distinction between rule-based and associative is problematic. Finally, I discuss experiments that support the view that constructive appraisal can be automatic.

Keywords: emotion, appraisal, automatic, constructive

Automatic constructive appraisal as a candidate cause of emotion

I sketch the contours of a debate revolving around the question whether appraisal theory offers a plausible account of emotion causation. I specifically focus on the criticism that appraisal is a non-automatic, rule-based process and therefore not a plausible cause of emotions, at least not of those emotions that arise automatically. In the first part of the paper, I discuss two strategies that appraisal theorists have adopted in response to this criticism and propose two alternative strategies of my own. In the second part, I summarize empirical data that were set up in the spirit of the last strategy.

My aim is to remove one criticism against the idea that appraisal is a cause of emotions. In doing so, I hope to render this idea more plausible. This is not the same thing as actively demonstrating that appraisal is the cause of emotions. This would require a different type of research (see Conclusion section). Before turning to the criticism and the strategies, I clarify what I think appraisal theory is all about.

Appraisal Theory

Appraisal theory has made two important contributions to our understanding of emotions compared to older theories, such as those of James (1890/1950) and Schachter (1964). These older theories proposed that stimuli in some unspecified way cause physical arousal. In James's theory, feedback of this arousal produces the emotional experience. In Schachter's theory, the additional step of interpretation of this arousal in light of the situation produces the emotional experience. An important lacuna in these theories is that they do not ask which stimuli lead to physical arousal in the first place and by what process the organism determines this (Kappas, 2006; Moors, in press; Power & Dalgleish, 1997). A first contribution of appraisal theory was to put a finger on this problem and to

call into being a separate phase in which a stimulus must be evaluated before an emotion (or arousal) can arise. The process charged with this evaluation was called "appraisal" (Arnold, 1960).

A second contribution of appraisal theory was to submit a concrete proposal about which stimuli do and which do not elicit an emotion, and which stimuli elicit specific emotions such as anger, fear, sadness, and joy. Appraisal theorists soon discovered that it is impossible to make a fixed list of stimuli that elicit emotions, or the same ones, in everyone. They emphasized that there are few if any one-to-one mappings between stimuli and emotions (Roseman & C. A. Smith, 2001). The same stimulus can elicit an emotion in some individuals or on some occasions but not in other individuals or on other occasions. The same stimulus can lead to different emotions in different individuals or on different occasions. Different stimuli can lead to the same emotion. Appraisal theorists have tried to discover the commonalities among stimuli that elicit an emotion or the same emotion, as well as the crucial differences among stimuli that elicit a vs. no emotion or that elicit different emotions. This exercise has led to the suggestion that emotions are reliably produced by constellations of (at least) two elements: a stimulus and a goal for which the stimulus is relevant (Frijda, 1986). For example, meeting a bear in the woods is not inherently emotion provoking; it is only so because it is relevant for one's goal for physical safety. Moreover, specific emotions are not evoked by specific classes of stimuli but instead by specific constellations of stimuli and goals. A constellation of match between a stimulus and a goal leads to a positive emotion whereas a constellation of mismatch leads to a negative emotion, irrespective of the specific stimuli or the specific goals at stake. A bear in the woods elicits a negative emotion because it constitutes a mismatch with one's goal for physical safety, but so does any stimulus that constitutes a mismatch with some goal. Appraisal theorists have proposed sophisticated rules for the further differentiation of positive and negative emotions into more specific emotions such as joy, hope, anger, fear, and

sadness. Examples of such rules are that anger and sadness are elicited by an actual mismatch, whereas fear occurs in response to a pending mismatch (Arnold, 1960); that the events are more easy to cope with in the case of anger than in the cases of fear and sadness (Scherer, 1988); and that the mismatch in anger is caused by another person, preferably by someone who intended it (Lazarus, 1991). Ultimately, the aim was to discover for each specific emotion a set of variables that is minimally (or typically) required to characterize its elicitors. Individual appraisal theorists vary with regard to the exact set of appraisal variables that they propose, but there is a fair degree of overlap.

If it is true that stimuli elicit (specific) emotions when they have certain values for the proposed variables, it seems natural to assume that the organism must be able to assess these values. This has led appraisal theories to present the appraisal process as consisting of various components. Each component deals with a different variable or a different type of information. The component of goal relevance determines whether the stimulus is relevant or irrelevant for the person's goals. The component of goal conduciveness determines whether the stimulus constitutes a match or a mismatch with a goal. The component of presence determines whether the match or mismatch is pending or whether it already happened. The component of coping potential determines whether a person can prevent a pending mismatch, or undo the consequences of an actual mismatch. The components of agency and blame determine whether the source of an event is animate (self/other) or inanimate and whether the agent caused the event on purpose. Some authors (e.g., Scherer, 1984) have added to this list, the component of novelty (or unexpectedness) to account for the emotion surprise, and the component of intrinsic valence (i.e., the valence of a stimulus independent of current goals) to account for the emotion disgust. Some appraisal theorists view these components as sequential steps, with a separate process for each component (e.g., Scherer, 1984). Others view them as the constituents of one single process (Lazarus & C. A. Smith, 1988; C. A. Smith & Lazarus, 1990). In

sum, the observation that emotions depend on the interaction of various sources of information has led appraisal theorists to portray appraisal as a compositional process, one that is made up of various components. Stripped to the bone, a process that integrates information from a variety of sources is a constructive process (Ferguson & Bargh, 2003). Formally, a constructive process is one that operates on more than one input at the same time, short, a multiple-input process. I wish to note that, although I believe that constructiveness is central to appraisal theory, I do not regard it as a defining feature of appraisal. In line with current appraisal theoretical consensus, I leave room for appraisal that is non-constructive (cf. See Fourth Strategy section).

Appraisal theorists have insisted right from the start that the appraisal process can and often does proceed automatically (Arnold, 1960; Frijda, 1986, 1993; Lazarus, 1991; Scherer, 1984, 1993a; see also Kappas, 2006). This means that it can operate under suboptimal conditions such as when there is little time, little attentional capacity, subliminal stimulus input, and when there is no intention to engage in the process (see Box 1). The view that appraisal can be automatic accommodates the observation that emotions often arise automatically. It also dovetails with the idea that emotions are adaptive in that they are able to mobilize the organism in an automatic sense (e.g., in response to a life-threatening event).

According to some appraisal theorists, appraisal is not only a necessary but also a sufficient cause of emotion (e.g., Lazarus, 1984). This claim needs to be qualified though. Consider the case in which a person appraises a stimulus as goal irrelevant and as a result, has no emotion. In this case, appraisal is present but an emotion is not; hence, appraisal is not sufficient for emotion. Two additional conditions are required. First, it is not the fact that a stimulus is appraised that makes it cause an emotion, but the fact that it is appraised as goal relevant. Thus, the presence or absence of an emotion is dependent on the content of appraisal (i.e., a specific value on the appraisal variable of

goal relevance). Second, the goal at stake must be highly important. In case of a low important goal, a state may be elicited that is not intense enough to qualify as a full-blown emotion (cf. Moors, 2007).

In summary, the first contribution of appraisal theory was to argue that an appraisal process must mediate between a stimulus and an emotion to inform the organism which stimulus is eligible to elicit an emotion (an emotion per se or a specific emotion). The second contribution was a concrete proposal about which stimuli elicit emotions (emotions per se and specific emotions). This led to the characterization of the appraisal process as one that is often compositional or constructive. The appraisal process was further characterized as one that is often automatic. In short, appraisal theory has three central claims: (a) appraisal is a necessary cause of emotion, (b) appraisal is often constructive, and (c) appraisal is often automatic.

Criticism

Opponents of appraisal theory have struggled with appraisal theory's third claim, that appraisal is often automatic. This is part of the reason why some opponents have rejected the first claim, that appraisal is a necessary cause of emotion (i.e., that appraisal is the cause of all emotions). It is also the reason why some opponents have rejected the weaker version of that claim, that appraisal is a typical cause of emotion (i.e., that appraisal is the cause of most emotions). Below, I explain the relation between the rejection of the third claim and the rejection of the strong version (cf. 1) and the weak version (cf. 2) of the first claim.

1. Critics have taken issue with the first claim, that appraisal is a necessary cause of emotion. They have adduced several empirical arguments to refute this claim (cf. Moors, 2007). One of these arguments rests on the assumption that appraisal cannot be automatic (i.e., a rejection of the third claim). Kunst-Wilson and Zajonc (1980) obtained an increase in liking for stimuli that were previously presented (i.e., mere exposure effect) even when these stimuli were not consciously

identified. This led Zajonc (1980) to conclude that liking of stimuli does not require prior cognitive processing. It may be noted that Zajonc talked about the relation between cognition and liking instead of the relation between appraisal and emotion. Nevertheless, Zajonc's position has been taken to challenge appraisal theory because appraisal is usually filed as a cognitive process (Lazarus, 1991; but see Kappas, 2006) and liking is sometimes seen as a minimal form of emotion (e.g., Barrett, 2006; Zajonc, 1980; but see Leventhal & Scherer, 1987) or as a first step in the coming into being of an emotion (e.g., Scherer, 1984). Thus, Zajonc's position that liking does not require cognition has been reinterpreted as the position that emotion does not require appraisal. Importantly, Kunst-Wilson and Zajonc's finding of liking-without-consciousness can only be taken as evidence for liking/emotion-without-cognition/appraisal if cognition/appraisal is equated with conscious cognition/appraisal, which entails a rejection of the possibility of unconscious (i.e., automatic in the sense of unconscious) cognition/appraisal. Thus, one argument against appraisal theory's first claim (that appraisal is a necessary cause of emotion) is based on a rejection of appraisal theory's third claim (that appraisal can be automatic). Most contemporary researchers accept the possibility of unconscious cognition (and so did Zajonc in later writings, 1984, p. 118) and the liking-without-consciousness argument is no longer considered a strong argument. However, the possibility of unconscious appraisal, at least the constructive type, is not equally broadly accepted (cf. See Second Strategy section).

I briefly mention three other empirical arguments that researchers have adduced against appraisal theory's first claim. One argument comes from priming studies (Murphy & Zajonc, 1993) showing that emotional primes (happy versus scowling faces) produced shifts in liking ratings of neutral target stimuli (Chinese ideographs) when primes were presented subliminally (4 ms) but not supraliminally (1s), whereas cognitive features (e.g., gender, symmetry, and size) of the primes

spilled over to targets when primes were presented supraliminally (1s) but not subliminally (4 ms). Murphy and Zajonc (1993) concluded that emotional features of situations are processed prior to cognitive features and hence that cognition is not necessary for the processing of emotional features. Without going into a detailed analysis of this argument (cf. Clore, Storbeck, Robinson, & Centerbar, 2005), it may be noted that the cognitive features in Murphy and Zajonc's research (symmetry, gender, and size) do not correspond to the cognitive features at issue in appraisal theory (e.g., goal relevance, goal conduciveness, and coping potential). A second argument are studies purporting to show that emotions can be directly triggered by physical stimulations coming from drugs or artificial posing of facial expressions (but for a critical review, see Niedenthal, Krauth-Grüber, & Ric, 2006). A third argument are neuro-anatomical findings showing that animals without a cortical brain are still capable of producing fear responses to previously conditioned stimuli (LeDoux, 1996). The latter argument rests on the assumption that appraisal cannot be subcortical (for more extensive discussions of the debate, see special issue, *Cognition and Emotion, 6*, 21, 2007). These additional arguments have led some appraisal theorists to weaken the first claim. Instead of arguing that appraisal is the cause of all emotions, they now argue that appraisal is the cause of most emotions and they are willing to accept the possibility that some marginal cases of emotional responses are not caused by appraisal (e.g., Frijda, 1993).

2. Some critics of appraisal theory not only reject the strong claim that appraisal is the cause of all emotions, but also the weaker claim that appraisal is the cause of most emotions (e.g., Berkowitz & Harmon-Jones, 2004; Cacioppo & Gardner, 1999; LeDoux, 1996; Öhman & Wiens, 2004). These critics have suggested that appraisal may be the cause of some, but certainly not of most emotions. In many cases, appraisals are consequences instead of causes of emotions. This view is based on the implicit or explicit assumption that appraisal is a rule-based process that operates on

propositional (i.e., verbal-like) representations and that is not likely to be automatic. Appraisal is accepted as a cause of emotions that occur under optimal conditions, but not of those that occur under suboptimal conditions. For example, Öhman and Wiens (2004) make a sharp distinction between a fast, automatic fear module and cognitive appraisal that is consciously accessible and occurs after the fact. They write that "cognitive models of anxiety typically assume a linear series of appraisal stages from input to output, and that several of these stages are accessible in conscious awareness. Thus input from the environment is elaborated by appraisal processes to converge in consciousness, where options for action are evaluated and decisions to act are taken" (Öhman & Wiens, 2004, p. 71). Some critics of appraisal theory are ambiguous about the automaticity of appraisal. On some occasions, they accept the possibility of automatic appraisals (as a theoretical possibility). On other occasions, especially in summary statements of appraisal theory, they revert to the stereotype that appraisal is non-automatic (slow, laborious) and they depict the appraisal process as the scrolling down a verbal checklist.

It is possible that some of these critics are simply misinformed about the fact that appraisal theory considers appraisal to be automatic (i.e., third claim). It is more likely, however, that they have genuine difficulty to reconcile the constructive character of appraisal (i.e., second claim) with its presumed automatic character (i.e., third claim). They find it unlikely that a process that integrates multiple sources of information can occur in the blink of an eye. To be fair, the idea of automatic constructive appraisal even sits uneasy with some appraisal theorists (e.g., those that take recourse to the first and second strategies discussed below).

In summary, some critics of appraisal theory are opposed to the strong claim that appraisal is a necessary cause of emotion and some of them are also opposed to the weaker claim that appraisal is a typical cause of emotion. In both cases, at least part of the argumentation is based on the rejection or

denial of appraisal theory's other claim, that appraisal is an automatic process. Several critics tend to view the appraisal process with its various components as a process that is too complex to be automatic. And a process that is not automatic is not considered to be a plausible cause of emotions, at least not of those emotions that arise automatically. Appraisal theorists have picked up this criticism. For example, Smith and Kirby (2001, p. 128) wrote "Critics of appraisal theory have tended to interpret the descriptions of complex and relational information involved in appraisal as implying that the process of appraisal is deliberate, slow, and verbally mediated. They then correctly note that such a process would fly in the face of common observations that emotions can be elicited very quickly, unbidden, often with a minimum of cognitive effort, and sometimes with little or no awareness of the nature of the emotion-eliciting stimulus." Appraisal theorists have felt the urge to defend themselves against this criticism. In the next sections, I discuss two strategies that appraisal theorists have turned to in response to the accusation that appraisal is too complex to be automatic. After that, I propose and examine two alternative strategies.

First Strategy

A first strategy that some appraisal theorists have turned to is arguing that appraisal was never really meant as a cause of emotions but rather as a constituent of emotional experience. According to this view, appraisal is not a process but a description of the structure of emotional experience. A person may actually be angry because she is tired, but her anger feels as if there is a mismatch with her goals, and as if someone else is to blame for it. Ellsworth (2006) argued that it is as pointless to say that appraisal is a cause of emotions as it is to say that eggs and other ingredients are the cause of a cake.[1] This view fits nicely with the idea expressed by some appraisal authors (e.g., Frijda, 1993; Scherer, 1993a) that the appraisals obtained with self-report measures do not reflect the causes of emotions but rather the structure of emotional experience. It should be noted that the role of appraisal

as a constituent of emotional experience is not in principle incompatible with the role of appraisal as a cause of emotions. Both roles can be regarded as two sides of a coin. If appraisal causes emotions, it is to be expected that part of these appraisals are reflected in emotional experience.

Second Strategy

A second strategy that appraisal theorists have turned to is arguing that appraisal is a causal process, but that appraisal theorists have provided a functional description of it and not an algorithmic one (cf., Reisenzein, 2001; Wehrle & Scherer, 2001; Roseman & C. A. Smith, 2001). The distinction between functional and algorithmic stems from a levels-of-analysis approach as proposed by Marr (1982). According to this approach, one process can be described at three levels of analysis. At the first or functional level, a process is described as a relation between input and output; it tells what the process does. For example, the process of adding numbers can be described as a relation between a pair of digits and their sum. At this level can also be situated the conditions under which the process operates (in addition to the stimulus input). Examples of conditions are the presence of ample time, abundant attentional capacity, a conscious input, and the intention to engage in the process. At the second or algorithmic level, a process is described in terms of the mechanisms that translate input into output. Examples are rule-based mechanisms and the associative mechanism. Digits can be added by counting the units of both digits (i.e., rule-based) or by directly retrieving the sum from memory (i.e., associative). This level also specifies the format of the representations or codes on which the mechanisms are thought to operate. Examples are propositional/symbolic (verbal-like) codes and perceptual (image-like) codes. The third or implementational level is concerned with the physical realization of a process in the brain. It specifies the brain structures and circuits involved. The three levels are related, but only loosely. For example, one functional process can be explained by different underlying mechanisms, and one mechanism can explain different functional processes.

As mentioned, defenders of the second strategy hold that the appraisal process as it figures in most appraisal theories is a process described at the functional level. The appraisal process produces an emotion for some event, but no commitments are made with regard to the mechanism and codes responsible for producing this emotion or with regard to the neural circuits involved.

Many appraisal theories can indeed be classified as functional theories that are only concerned with the relation between appraisal variables and emotions. A handful of appraisal theories have also ventured hypotheses about the algorithmic level (mechanisms and codes) and about the conditions under which appraisal can occur (which is strictly speaking a functional matter). A popular view is that there are (at least[2]) two modes of appraisal: one is rule based; the other is associative (Clore & Ortony, 2000; Leventhal & Scherer, 1987; C. A. Smith & Kirby, 2000, 2001; Teasdale, 1999; van Reekum & Scherer, 1997; for a review see E. R. Smith & Neumann, 2005).[3] Dual mode models of appraisal draw on dual mode models developed in other domains of psychology, such as social cognition (E. R. Smith & DeCoster, 2000; Strack & Deutsch, 2004) categorization (e.g., Rouder & Ratcliff, 2004), and reasoning (Sloman, 1996). In the rule-based mode, performance relies on a rule-based mechanism. That is, a mental rule is applied to an input (or a representation of the input) and computation of the rule produces an output. Producing the sum of a pair of digits by counting the units in both digits is an example of a rule-based mechanism. In the associative mode, performance is based on an associative mechanism. That is, an input activates stored representations of similar past inputs. This activation, in turn, spreads to associated stored representations that determine the output. Producing the sum of a pair of digits by retrieving it from memory is an example of an associative mechanism. The associative mechanism has sometimes been characterized as a pattern completion mechanism. Knowledge stored in memory is organized in schemata. The activation of one element in the schema activates the remaining information in the

schema. For example, the barking of a dog calls to mind a furry creature, that salivates, has a tail, and is called "dog". A single stimulus can lead to the activation of an entire pattern of information.

Applied to emotion elicitation, rule-based mechanisms are considered fit for the computation of appraisal values and integration of these values in a pattern. Once a stimulus has led to an appraisal pattern, the stimulus and its associated appraisal pattern can be stored in memory. The associative mechanism corresponds to the retrieval of a stored appraisal pattern and is triggered when the same or a similar stimulus is encountered (Clore & Ortony, 2000). It is important to note that activation of stored information by mere stimulus input is a single-input process. The constructive nature of appraisal is thus not preserved in the associative mode.

The average dual mode model has the assumption that rule-based mechanisms operate on propositional/symbolic codes whereas the associative mechanism operates on perceptual codes (e.g., E. R. Smith & DeCoster, 2000). Another assumption is that the associative mechanism is automatic whereas rule-based mechanisms are non-automatic (or less automatic than the associative one; Cleeremans & Destrebecqz, 2005; Logan, 1988; Sloman, 1996; E. R Smith & DeCoster, 2000; Strack & Deutsch, 2004). For example, E. R Smith and DeCoster (2000) write that "Associative retrieval […] constitutes the effortless processing mode. The [rule-based] processing mode is more conscious and effortful; it involves the intentional retrieval of explicit, symbolically represented rules" (p. 108).

Dual mode models of appraisal echo these assumptions. Appraisal in the rule-based mode is said to operate on propositional/symbolic codes and in a non-automatic way; appraisal in the associative mode is said to operate on perceptual codes (but see C. A. Smith & Kirby, 2001) and in an automatic way. When conditions are optimal, people use a rule-based mechanism to compute the output of individual appraisal components and integrate them in a pattern. For example, to compute goal conduciveness, they compare stimulus information (actual state) with motivational information

(desired state). A match between actual and desired state results in a positive emotion, a mismatch in a negative emotion. This information can further be integrated with information about coping potential and agency to determine whether anger or fear is to ensue. When conditions are suboptimal, however, people have to rely on memory recordings of previously computed appraisal patterns, which are activated on the basis of mere stimulus input. Thus, under suboptimal conditions, the flexibility that comes with constructive processing in the rule-based mode is lost (cf. Clore & Ortony, 2000; C. A. Smith & Kirby, 2001). Suppose that a person is hungry and is served chocolate cake. Dual mode theorists would say that under optimal conditions, a person compares the chocolate cake with her motivational state, which results in the output that the cake is goal conducive and hence positive (or to-be-approached). An association is then formed in memory between the representation of the chocolate cake and the representation of positive valence. On a later occasion, when conditions are suboptimal, the person has not choice but to rely on this stored valence. This valence is appropriate when the person is in the motivational state in which the association was originally formed (hungry), but inappropriate when she is in a different motivational state (satiated). In other words, the flexibility that appraisal theory set out to explain is lost under suboptimal conditions. As Clore and Ortony (2000) put it, each mode of appraisal carries benefits and costs. The associative mechanism is fast and automatic but relatively inflexible and more error prone. The rule-based mechanism takes more time but allows greater flexibility.

It is interesting to note that many dual (or multi) mode theorists have argued that appraisal in the associative mode is the royal road to emotion elicitation (Leventhal & Scherer, 1987; C. A. Smith & Kirby, 2001; Teasdale, 1999). For example, Leventhal and Scherer (1987) argued that emotions are preferably elicited by appraisal in the schematic mode (which is their term for the associative mode).

Appraisal in the conceptual mode (which is their term for the rule-based mode) can only elicit emotions indirectly by "calling up" the schematic mode.

To sum up, dual (or multi) mode theorists of appraisal and many critics of appraisal theory share the assumption that emotions can be elicited by mechanisms of (at least) two kinds: associative and rule-based. Dual mode theorists of appraisal use the term appraisal to cover both mechanisms whereas their critics reserve it for the rule-based variant. Thus, dual mode theorists of appraisal have a broader view of appraisal than their critics. However, dual mode theorists of appraisal seem to agree with their critics (a) that constructive appraisal asks for a rule-based mechanism, and (b) that rule-based mechanisms are usually non-automatic. This means that under suboptimal conditions, the constructive nature of appraisal and the flexibility that comes with it are lost. I present and examine two alternative strategies (the third and the fourth strategy) that attempt to preserve the constructive flavor of appraisal even under suboptimal conditions. The third strategy argues against "(b)". The fourth strategy builds on a rejection of "(a)".

Third Strategy

Appraisal theorists who adopt the second strategy and accept a dual mode model make the a priori assumption that rule-based appraisal is likely to occur under optimal conditions and is replaced with stimulus-based memory retrieval under suboptimal conditions. A third strategy might be to question this a priori assumption and to investigate empirically whether rule-based appraisal can operate under suboptimal conditions (i.e., be automatic). Empirical research concerned with the automaticity of rule-based processes faces at least two problems. One is that automaticity is a gradual notion and not a matter of all or nothing (Bargh, 1992). This complicates the diagnosis of automatic vs. non-automatic processes One solution is to specify the features of automaticity that apply and to

make only relative conclusions for each feature, thereby choosing a standard for comparison or a subjective criterion (cf. second part of Box 1).

A more difficult problem is that there is no satisfactory criterion to distinguish the associative mechanism from rule-based ones (cf. discussions in Hahn & Chater, 1998; Moors & De Houwer, 2006b). In Box 2, I discuss three proposals for how to draw the line between the associative mechanism and rule-based ones: expressability in an IF-THEN format, abstract vs. non-abstract representations, and perfect vs. partial matching. The research literature contains several other proposals for how to distinguish rule-based mechanisms from associative ones, but none seems unequivocal. There are at least three options that one can turn to in response to this problem. A first option is to continue the search for a distinction between rule-based and associative mechanisms that does lead to an unequivocal empirical test. A second option is to endorse a gradual view of this distinction (e.g., Pothos, 2005) and to make relative conclusions or to specify a subjective criterion for calling some mechanism rule-based or associative. A third option is to abandon the search for a distinction between rule-based and associative mechanisms and to stick to the functional level of process description. It is the third option that I resort to in the present paper (see Fourth Strategy section). It is important to note that process descriptions at the functional level can be couched in more concrete terms (specifying the concrete content of input and output) or in more abstract terms (specifying the content of input and output on a more abstract level, or specifying only the structure of input and output). Thus, researchers who confine themselves to the functional level can focus on abstract descriptions of processes and in this way continue the search for regularities.

Fourth Strategy

In the section about the second strategy, I argued that critics of appraisal theory as well as dual mode theorists of appraisal find it unlikely that constructive appraisal proceeds automatically

and acts as a cause of most emotions. According to my analysis, this is due to the underlying assumptions (a) that the constructive nature of appraisal necessitates a rule-based mechanism, and (b) that rule-based mechanisms are non-automatic. In the previous section, I argued that it is difficult to disprove "(b)" because of the difficulty to distinguish between the associative mechanism and rule-based ones. In the present section, I take on a different path, which consists in arguing against "(a)".

I stated that one of the major contributions of appraisal theory was to emphasize the variable relation between stimuli and emotions and to formulate concrete rules about which variables are crucial in predicting whether an emotion will follow (and which one). To guarantee that emotions are elicited according to these rules, the process mediating between stimuli and emotions must be able to assess the values on these variables. If emotions are indeed elicited by constellations of stimuli and goals (and other information) rather than by stimuli alone, then the mediating process should be able to determine the nature of the constellation and not simply the nature of the stimulus. Chocolate cake can make a person happy when she is hungry but disgusted when she has just eaten five pieces of it. Before an emotion of happiness or disgust can arise, information about the stimulus must be combined with information about the person's motivational state. This led to the characterization of appraisal as a process that is often constructive, one with multiple inputs (minimally two: a stimulus and a goal).

The characterization of a process as constructive can be regarded as a characterization at the abstract functional level. The number of inputs entering a process is clearly a functional matter (because the functional level is about inputs and outputs). It is also abstract because it specifies the structure and not the content of the input.

Various mechanisms at the algorithmic level may be compatible with the functional requirement of handling multiple inputs. Rule-based mechanisms are well suited for the constructive

task to integrate multiple inputs. But a constructive process does not have to be rule-based. A constructive process can also be associative. Examples of constructive associative processes are the multiple-input retrieval processes that can be found in occasion setting literature (Davidson, 1998), situated cognition models (E. R. Smith & Zaraté, 1992), and connectionist or dynamic systems models[4] (Barrett, Ochsner, & Gross, 2007; Lewis, 2005).

In occasion setting, an occasion setter is conceived of as a node that modulates the relation between the memory representations of a conditioned stimulus (CS) and an unconditioned stimulus (US). For example, the motivational state hunger may be conceived of as an occasion setter, a food stimulus as the CS, and the positive postingestional consequences of food intake as the US. The CS entertains both an excitatory and an inhibitory link with the US that cancel each other out when the organism is not hungry. When the organism is hungry, the occasion setter is active and exerts an inhibitory influence on the inhibitory link between CS and US. As a result, only the excitatory relation between CS and US remains, and the food stimulus leads to a positive evaluation. The process described is constructive because it combines two types of information (stimulus and goal/motivational state), yet it is purely associative (there is no computation, only activation of memory traces).

Situated cognition models (Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; E. R. Smith & Zaraté, 1992) assume that context information shapes the kind of stimulus information that is activated in memory. For example, memory does not have a single representation for the concept dog, but many, one for each context in which dogs can be encountered. The presence of a dog in a particular context activates the specific dog representation that matches the context. In E. R. Smith and Zaraté's (1992) exemplar-based model of social judgment, exemplars are first categorized according to their similarity with stored exemplars and then adopt the valence tag associated with the

category. A critical assumption in this model is that motivational and other context factors determine which stimulus dimension is selected as the basis for similarity with stored exemplars and hence categorization. For example, a young cook can be categorized according to his/her age or according to his/her profession. Situated cognition models have also been applied to emotion. Barrett (2006), for example, argued that people do not have just one representation (or schema) for anger, but one for each context in which anger can occur. For example, anger on the highway is different from anger in a waiting cue. The process at stake in situated cognition models is constructive because it combines two types of information (stimulus and context), yet it is purely associative (no computation, only retrieval).

Connectionist models rest on the metaphor of the mind as a network of associations. Some older models are localist (with one node for each representation), but most modern ones are distributed (concepts are represented subsymbolically by a pattern of activation that is distributed among many nodes). The only mechanism allowed in these models is associative. Processing comes down to the activation of patterns of associations. A typical feature of connectionist networks is that they have multiple entry points that are activated simultaneously. The associative process in connectionists models is thus constructive. Because connectionist models only have room for the associative mechanism, they count as unimode models and offer an alternative to classic models such as dual mode models (e.g., Sloman, 1996) and unimode models that favor only rule-based mechanisms (e.g., Kruglanski, Erb, Pierro, Mannetti, & Chun, 2006). The idea that connectionist models are incompatible with classic ones has led so-called eliminativists to propose that classic models should be eliminated and replaced by connectionist ones. So-called implementationalists, on the other hand, argue that classic models and connectionist ones do not address the same level of process understanding (the algorithmic level) and thus are not in principle incompatible. Instead, they

view connectionist models as a step toward the implementation of classic models. According to them, connectionist models have the power to bridge the gap between the algorithmic and the implementational level.

I suggest that the crucial contrast is no longer between rule-based processes and associative ones but between constructive (i.e., multiple-input) processes and non-constructive (i.e., single input) ones. As mentioned earlier, dual mode theorists of appraisal tend to map constructive processes to rule-based ones, and non-constructive processes to associative ones. I pointed out that constructive processes can be rule-based as well as associative. I agree with dual mode theorists of appraisal that appraisal does not necessarily ask for a rule-based process, but this does not force us to accept a non-constructive associative process as the only alternative. Appraisal theory may not be dedicated to rule-based processing, but I believe it is dedicated to constructive processing. As explained earlier, a non-constructive process cannot deliver the same flexibility as a constructive process can. By suggesting that constructive appraisal can occur under optimal conditions but is replaced by non-constructive retrieval under suboptimal conditions, dual mode theorists of appraisal accept that flexibility is lost under suboptimal conditions. I consider this to be a weakening of appraisal theory and propose a fourth strategy to respond to the criticism.

The fourth strategy is to investigate the automatic nature of constructive (instead of rule-based) processes involved in appraisal. This strategy eludes the difficulty to distinguish between the associative mechanism and rule-based ones, yet it preserves the core of appraisal theory. Rather than assuming a priori that complexity and automaticity do not go together, it should be determined empirically how much complexity can be handled in suboptimal conditions, and thus how much flexibility is possible.

In line with defenders of the second strategy, I define appraisal on the functional level of process description. Appraisal is a process that produces an evaluation of the stimulus along one or more variables proposed in appraisal theories, such as goal relevance, goal conduciveness, intrinsic valence, coping potential, and agency. Defining appraisal on the functional level entails that there are no a priori assumptions about the conditions under which it occurs (optimal vs. suboptimal), the underlying mechanisms (associative vs. rule-based), or the format of the representations on which it operates or that it produces (propositional vs. perceptual). This definition of appraisal is broad because it covers a wide range of mechanisms and codes. It is not all-inclusive, however, because it excludes processes that deliver a value for variables other than appraisal variables. Processes that deal with location, color, gender, and other non-affective semantic categories do not fall within the boundaries of the concept of appraisal.

I distinguish between two types of appraisal: one type is constructive (multiple-input); the other is non-constructive (single-input). Even though I claim that emphasis on constructive appraisal is one of the unique contributions of appraisal theory, I leave room for appraisal that is not constructive. Some individual appraisal variables require a constructive process, whereas others do not. Constructive processes are plausibly involved in the appraisal variables of goal relevance, goal conduciveness, and expectancy or novelty. Determining whether a stimulus is goal relevant or goal conducive (cf. example above) seems to require a comparison between two inputs: the stimulus (i.e., actual state) and a goal (i.e., desired state).[5] A comparison seems also required to determine whether a stimulus (i.e., actual state) conforms to one's expectations (i.e., expected state). A constructive process seems less crucial for other appraisal variables such as intrinsic valence. Indeed, to determine the valence of a stimulus independent of current goals or other aspects of the context, a single-input retrieval process seems sufficient. Still other appraisal components such as coping potential and

agency/blame may ask for a constructive process on some occasions but a non-constructive one on others. To determine whether one can cope with a negative event often requires a comparison of one's actual power with the power required to prevent or overcome the event. There may be cases, however, in which coping potential can be determined on the basis of a single cue (e.g., some negative events can never be undone). A constructive process may not be necessary to determine the agent that caused a stimulus in case there is only one potential agent. In case there are more, however, agent and event must be linked in some way and this may ask for a constructive process.

For theorists who view the appraisal process as a sequence of steps in which each step produces a value for a single appraisal variable (e.g., Scherer, 1984), the processes involved in these steps are completed one after the other and the emotion becomes more specific with each step. Some steps may require a constructive process whereas others may not. For theorists who view the appraisal process as a single process (e.g., C. A. Smith & Lazarus, 1990), the various appraisal variables constitute various sources of information that must be combined into a single pattern. This pattern determines the nature of the ensuing emotion. Here, the entire appraisal process is constructive. In sum, constructive processes may be involved in individual appraisal variables as well as in the integration of appraisal values into a pattern. In the next section, I discuss experiments that were set up in our lab to investigate the automaticity of constructive appraisals.

Investigating the Automaticity of Constructive Appraisals

To demonstrate that constructive appraisal can be automatic, investigators should elicit responses (effects) and demonstrate that these are based on automatic constructive appraisal. This entails demonstrating that the underlying process: (a) can be automatic, (b) is constructive, and (c) qualifies as appraisal.

(a) The degree to which a process is automatic can be diagnosed by looking at the degree to which one or more features of automaticity apply, such as fast, uncontrolled in the promoting sense (i.e., unintentional), uncontrolled in the counteracting sense, unconscious, and efficient. This amounts to investigating the conditions under which the process operates. In line with the gradual view that my colleagues and I endorse, we consider the evidence for individual features separately, and do not infer the presence of one feature (e.g., unintentional) on the basis of the presence of another (e.g., fast) (Bargh, 1992; Moors & De Houwer, 2006a). To investigate the automaticity of constructive appraisals, we used variants of the affective priming task (Bargh, Chaiken, Govender, & Pratto, 1992; Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Hermans, De Houwer, & Eelen, 1994). Before going into the details of our experiments, I briefly describe the standard affective priming task and explain why this task is suitable for the diagnosis of automaticity features.

In a standard affective priming task (See Figure 1), participants are shown a series of trials. Each trial consists in the brief presentation of a positive or negative prime stimulus, rapidly followed by the presentation of a positive or negative target stimulus. On half of the trials, called congruent trials, the valence of prime and target is the same (positive-positive or negative-negative). On the other half of the trials, called incongruent trials, the valence of prime and target is opposite (positive-negative or negative-positive). Participants are asked to respond to the targets as quickly as possible by evaluating them as positive or negative. A congruency effect is found when responses are faster and/or more often correct on congruent than on incongruent trials. The observation of a congruency effect indicates that the valence of the primes influenced processing of and responding to the targets. This in turn indicates that prime valence was processed under the conditions created by the experiment. An analysis of these conditions is informative about the features of automaticity that apply to the process of evaluating the primes (cf. Moors, Spruyt, & De Houwer, in press). The short

interval between the onsets of primes and targets (stimulus onset asynchrony, SOA) combined with the short response times to the targets shows that evaluation of the primes can be rapid. Because prime valence is irrelevant for the task to respond to the targets, participants are not encouraged to pursue the intention to process prime valence. This aspect of the procedure supports the hypothesis that prime valence can be processed unintentionally, or at least, without the participants' conscious intention. Another strategy that researchers have used to discourage participants from focusing on the valence of the primes is to replace the evaluative target task with a non-evaluative task such as a lexical decision task (Wentura, 2000) or a naming task (e.g., Bargh, Chaiken, Raymond, & Hymes, 1996; Spruyt & Hermans, 2008). When participants do not focus on valence in general, they are also less likely to be focus on prime valence in particular. It is even likely that participants in priming tasks pursue the goal to avoid processing prime valence rather than to engage in processing it. They may experience that processing the valence of the primes interferes with the task of responding to the targets. If participants indeed have the goal to avoid evaluating the primes, the fact that they do evaluate them demonstrates that this process can be uncontrolled in the counteracting sense. Support that the process of evaluating the primes can be efficient comes from affective priming studies in which a secondary task, simultaneously performed with the priming task, did not reduce the strength of the congruency effect (Hermans, Crombez, & Eelen, 2000). Finally, congruency effects have been observed when primes were presented subliminally (e.g., Draine & Greenwald, 1998; Klinger, Burton, & Pitts, 2000), which shows that evaluation of the primes can be triggered on the basis of unconscious input.

Please insert Figure 1 about here

(b) In standard affective priming studies, the prime stimuli are isolated words or pictures for which participants most likely have a fixed valence stored in memory. In order to process the valence of a prime, participants only have to activate the memory trace leading to the representation of the prime and its associated valence tag. Activation of this memory trace only requires a single input: the prime stimulus. These studies therefore provide no evidence for the possibility that constructive processes can be automatic. To test this possibility, we specifically designed two sets of studies. In one set, we investigated whether the constructive comparison process involved in the appraisal of goal conduciveness can be automatic. In another set, we investigated whether the constructive process required for integrating information about valence and coping potential can be automatic.

(c) To show that priming effects rely on automatic constructive appraisal not only requires showing that the processes underlying these effects are automatic and constructive, but also that they qualify as appraisal. Based on my functional definition of appraisal as evaluation of a stimulus on variables proposed in appraisal theories, constructive appraisals can be delineated from other constructive processes on the basis of the variables involved. In the first set of studies we manipulated the goal conduciveness of the stimuli. In the second set of studies, we manipulated the intrinsic valence or goal conduciveness of the stimuli and the coping potential of the participants. The variables goal conduciveness, intrinsic valence, and coping potential are explicitly proposed in most appraisal theories. It can thus be confirmed that in both sets of studies, the constructive processes that we manipulated qualified as appraisal. I describe both sets of studies in turn.

Automatic Integration of Stimuli and Goals?

In a first experiment (Moors & De Houwer, 2001, see Figure 2), participants received a series of trials and each trial consisted of two phases: a goal-inducing phase and a priming phase. In the goal-inducing phase, a game rule stipulated that one color (e.g., yellow) would be rewarded during

that trial (10 points) and another color (e.g., blue) would not. Participants then played a game in which they tried to produce the rewarded color: The letters Y (referring to yellow) and B (referring to blue) appeared on screen in quick alternating succession and participants tried to press a key at the exact moment at which the letter of the rewarded color was on screen. In the priming phase, a yellow or blue stimulus (series of Xs) was presented as the prime and participants were told that the color of the prime corresponded to the letter that they had hit during the goal-inducing phase.[6] In this way, the prime conveyed feedback about the participants' performance of the game. The prime stimulus was goal conducive or had a positive motivational valence[7] when it was in the rewarded color; it was goal inconducive or had a negative motivational valence when it was in the non-rewarded color. For example, when yellow was rewarded, a yellow prime was positive and a blue prime was negative. Importantly, the rewarded color and the prime color varied randomly across trials. Thus, participants could not store for each color a valence tag that was valid throughout the experiment. To determine the valence of the primes, participants could not rely on stimulus-based memory retrieval, but had to compare the rewarded color (desired state) with the prime color (actual state). The prime was presented very briefly (200 ms) and was immediately (after 100 ms) followed by a positive or negative target word. Participants had to evaluate the targets as quickly as possible. We obtained congruency effects, with faster responses and less errors when prime and target valence were the same than when they were opposite. Such congruency effects indicate that the constructive process necessary to determine the prime valence can occur under the conditions created by the experiment. These conditions argue for the relative automaticity of this process, in the sense of fast and unintentional. The short SOAs between prime and target combined with the short response times to the targets show that the critical process of evaluating the primes occurred rapidly. The fact that the prime valence was irrelevant for the task to respond to the targets as quickly as possible during the

priming phase of each trial supports the idea that evaluation of the primes occurred without the (conscious) intention to do so.

The latter argument cannot be considered conclusive, however. The participants in our studies may have been encouraged to intentionally process the prime valence because it informed them about their performance on the goal-inducing task. This issue was examined further in two studies (Moors, De Houwer, Hermans, & Eelen, 2005). In one study, we obtained priming effects when feedback about the goal-inducing task (the prime) was presented a second time (1500 ms) after the target response was given. This was done to discourage participants from focusing on the primes. Priming effects were also obtained in another study, in which participants were forced to respond within 600 ms after target onset. In case participants would still have the conscious intention to process prime valence, implementation of this intention was made very difficult. In addition, priming effects did not differ between participants who did and those who did not report having focused on the valence of the primes.

Please insert Figure 2 about here

In another series of subsequent studies (Moors, De Houwer, & Eelen, 2004), we investigated further whether a constructive process was really required to determine the valence of the primes. In the experiments described above, participants could not rely on a fixed stored valence tag for each color because the rewarded color and the prime color were randomly varied across trials. We concluded that participants had to compare the rewarded color and the prime color each time a prime was presented. According to an alternative explanation, however, it is possible that participants conducted the crucial comparison prior to prime presentation immediately after the game rule was

presented. The result of this comparison could have been stored in memory and subsequently retrieved upon prime presentation. Hence, a single-input retrieval process could have sufficed to determine the valence of the primes. The next study (Moors et al., 2004, Experiment 1) was set up to test this alternative explanation. This study was similar to the first experiment described above except that the game rules stipulated that either an animal or a profession would yield ten points, the alternating letters were A (indicating animal) and P (indicating profession), and primes were animal exemplars (e.g., LIZARD) or profession exemplars (e.g., SURGEON) randomly picked from a list of 40 non-stereotypic exemplars. In this experiment, we thought it not very likely that participants would generate all exemplars from both categories and tag them as positive or negative prior to prime presentation. Nevertheless, congruency effects were obtained.

According to an alternative explanation for this finding, however, participants did not tag each exemplar as positive or negative prior to prime presentation, but rather the entire categories of animal and profession. A subsequently presented prime exemplar merely had to be assigned to its category before inheriting the category's valence tag. According to this explanation, the valence of the primes was determined by the processes of categorization and retrieval instead of a constructive comparison process. To test this explanation, we conducted an experiment (Moors et al., 2004, Experiment 2) that was similar to the previous one, except that now two types of trials were presented intermixed: On one third of the trials, a category label (ANIMAL or PROFESSION) was presented as the prime. The participants were told that category label primes yielded a reversed feedback of their performance on the goal-inducing task. For example, when animal was rewarded, the prime ANIMAL indicated failure instead of success, whereas the prime PROFESSION indicated success instead of failure. On the remaining two thirds of the trials, exemplars were presented as primes and feedback was normal as in the previous experiments. We obtained a congruency effect for the

exemplar primes but not for the category label primes. This result is more in line with an explanation that prime valence was determined by a comparison process than with an explanation that category labels were tagged with positive or negative valence prior to prime presentation and that primes inherited this valence upon prime presentation. If participants would have tagged the categories of animal and profession prior to prime presentation, we would have expected a congruency effect to occur also for the trials with ANIMAL and PROFESSION as primes.

In the next experiment (Moors et al., 2004, Experiment 3), we obtained support against another alternative explanation. According to this explanation, the crucial comparison took place immediately after presentation of the game rule, and the valence resulting from this comparison spread to the exemplars of each category in an unconscious manner. This valence could be retrieved upon the subsequent presentation of the prime. The experiment was identical to the one in which only exemplar trials occurred (Moors et al., 2004, Experiment 1), except that now primes were either stereotypic or non-stereotypic exemplars of animals and professions. If some kind of spreading of valence mechanism would indeed be operative, one may expect that, given certain assumptions, stereotypic exemplars would be more likely to receive valence than non-stereotypic ones. As a consequence, one may expect a stronger congruency effect for trials with stereotypic primes than for trials with non-stereotypic primes. The results of this experiment, however, showed equally strong congruency effects for both types of trials. This result further corroborates the hypothesis that prime valence was determined by a comparison process instead of a single-input retrieval process.

To summarize, I described a variant of the affective priming task designed to investigate whether the constructive comparison process involved in the appraisal of goal conduciveness (or motivational valence, as we called it) can be automatic. The congruency effects obtained with this experiment were further examined in two series of subsequent studies. In the first series, we obtained

further support for the automaticity of this effect. The second series corroborated that prime valence was determined by a constructive comparison process instead of by a single-input retrieval process. In the next section, I focus on the constructive process involved in integrating valence information with coping information. I describe one study that constitutes a first step in what should become a more elaborate set of studies.

Automatic Integration of Valence with Coping Potential?

We conducted a variant of the affective priming task in which each trial consisted in a game phase and a priming phase. During the game phase, participants played a very simple Pac-Man game. They walked a Pac-Man through a maze eating pellets (thereby earning points) until a ghost (which is negative or goal inconducive) suddenly popped up close to the Pac-Man. Together with the ghost, either a wall appeared or no wall appeared. In case a wall appeared, the Pac-Man was trapped and coping potential was low. In case no wall appeared, the Pac-Man could flee and coping potential was high. The image of the ghost with or without a wall constituted the prime. We assumed that integration of a negative stimulus (the ghost) with low coping potential (being trapped) would result in negative prime valence, whereas integration of a negative stimulus with high coping potential would result in positive prime valence. Each prime was immediately (after 300 ms) followed by a positive or negative target word which appeared in the centre of the maze. Participants had to evaluate the target as quickly as possible before they could flee (in high coping trials) or before they were destroyed (in low coping trials). We obtained a congruency effect, $F(1,31) = 5.68$, $p < .05$, with faster responses to trials on which prime and target had the same valence ($M = 906$) compared to trials on which they had an opposite valence ($M = 928$).

This result suggests that the constructive process of integrating information about valence and coping potential can take place automatically in the sense of fast and without conscious intentions. As

in the former set of studies, it should be investigated further whether a constructive process was really required to determine the valence of the primes. It remains possible that participants engaged in the integration of negative information with coping information early on in the experiment and that they attached a negative valence in memory to the stimulus "wall" and a positive valence to the stimulus "no wall". If this was indeed the case, the prime valence could have been determined by retrieval of these valence tags. The results of this experiment therefore do not provide conclusive evidence that coping information and valence information can be automatically integrated.

The two sets of studies described above are a first step toward examining the amount of complexity and integration that is possible in a short amount of time and when participants are asked to concentrate on another stimulus or variable than the critical one. Our studies show that some constructive appraisals can take place under these conditions, and hence that they are candidate causes of emotions that appear under these conditions. In the next section, I spend a few lines on research concerned with the automatic processing of individual appraisal variables, irrespective of whether they are based on a constructive process or on single-input retrieval. These studies are relevant for the issue of automatic constructive appraisal because only if individual appraisal components can be automatic is there a possibility that (further) integration of them can be automatic as well. After that, I compare our findings with findings showing the automaticity of constructive processes outside the domain of emotion. These studies can inform us about the general level of complexity that can be dealt with under suboptimal conditions.

Support for Automaticity of Appraisal Components Irrespective of Underlying Process

Diverse research traditions provide useful information about the automatic processing of appraisal variables such as goal conduciveness, intrinsic valence, coping potential, agency/blame, goal relevance, and novelty. The first set of studies discussed above supports the automaticity of goal

conduciveness appraisal. The experiment described in the second set was designed to find support for the automatic integration of intrinsic valence and coping potential. To the extent that the effect obtained in this experiment was indeed based on the integration of both appraisal variables, it also provides support for the automatic processing of the individual appraisal variables of intrinsic valence and coping potential. The automatic processing of intrinsic stimulus valence is further amply documented in the standard affective priming research discussed above (Bargh et al., 1992; Fazio et al., 1986; Hermans et al., 1994) as well as in studies using ERP method (Grandjean & Scherer, 2008; Righart & De Gelder, 2005).

In recent studies (Moors & De Houwer, 2005), we found that participants can automatically determine the relative status or power of a target person in pictures of social interactions in which one person is dominant and the other is submissive. In several appraisal theories, relative power is considered an important ingredient of the appraisal component of coping potential (e.g., Scherer, 1988). "In the case of an obstructive event brought about by a conspecific aggressor or predator, the comparison between the organism's estimate of its own power and the agent's perceived power is likely to decide between anger and fear and thus between fight and flight" (Ellsworth & Scherer, 2003, p. 580). There is reason to assume that determining one's relative status is based on a comparison between one's own status and that of the interaction partner (i.e., a constructive process). This being said, it is possible that participants relied on learnt cues (e.g., an angry expression) to determine the status of the target person.

Support for the automatic detection of goal relevance comes from studies using attentional bias tasks (e.g., the modified Stroop task, the dot probe task, the spatial cueing task, and the visual search task) demonstrating selective attention to goal-relevant compared to neutral stimuli (see Williams, Mathews, & MacLeod, 1996). The finding that goal-relevant stimuli exerted an influence

on attention indicates that goal relevance was processed under the conditions created by the experiment. These conditions provide information about the automaticity features that apply to this processing. For example, attentional bias effects obtained using a dot probe task with subliminal cue presentation support the idea that goal relevance can be processed automatically, in the sense of based on unconscious input (e.g., Mogg, Bradley, & Williams, 1995). There is disagreement about whether goals are necessary for attention orienting. Some researchers have argued that attention orienting may also be triggered by novelty (Gati & Ben-Shakar, 1990; Sokolov, 1963; but see Bernstein, 1969). Further support for automatic appraisal of novelty comes from neuroscientific studies (e.g., Berns, Cohen, & Mintun, 1997).

There is also evidence that the appraisal component of agency/blame can be automatic. With regard to blame, recent studies show that people automatically attribute intentionality when seeing or reading about other people's actions (e.g., Dik & Aarts, in press; Hassin, Aarts, & Ferguson, 2005). Moreover, given certain characteristics of movements, people even spontaneously attribute intentionality to non-living entities (see review by Scholl & Tremoulet, 2000).

Neuroscientific studies sometimes provide indirect support for automatic appraisal. The amygdala is a structure that is strongly associated with automaticity. It can be activated by features that are not consciously perceived and in the absence of intention (e.g., Whalen et al., 1998; although note that some studies have shown that amygdala activation can to a certain extent be controlled, Cunningham, Van Bavel, & Johnsen, 2008; Ochsner et al., 2004). The consensual view is that the amygdala detects threatening information (e.g., Öhman & Wiens, 2004), or that it detects negative information in general (i.e. appraisal of intrinsic valence, Hariri, Tessitore, Mattay, Fera, & Weinberger, 2002). Alternative views include that it is a novelty or unexpectedness detector (signaling mismatches between actual and expected states; e.g., Schwartz et al., 2003) and that it is a

goal relevance detector (signaling matches or mismatches between actual and desired states, e.g., Sander, Grafman, & Zalla, 2003). It is difficult to keep apart novelty and goal relevance because novel stimuli can be viewed as potentially goal-relevant (Bernstein & Taylor, 1979). Automaticity is not restricted to subcortical structures. An example of a cortical structure that seems relevant for the question of automatic appraisal is the anterior cingulate cortex (ACC). Detecting goal conduciveness seems to have at least structural resemblance with conflict detection processes that are typically situated in the ACC (Botvinick, Braver, Barch, Carter, & Cohen, 2001). ERP studies show that conflict detection has both unaware (i.e., ne/ERN) and aware (i.e., pe) components (Nieuwenhuis, Ridderinkhof, Blom, Band, & Kok, 2001).

Support for Automaticity of Constructive Processes Outside the Domain of Emotion

In the first set of studies discussed above, we examined the influence of goals on stimulus evaluation. In the second set, we examined the influence of coping options on stimulus evaluation. These influences can be regarded as specific kinds of context effects (cf. Frijda, 2007). Indeed, the motivational context and the coping context are specific kinds of contexts and stimulus evaluation is a specific kind of process. It may be instructive to compare our findings with findings about the automaticity of context effects outside the domain of emotion. Context effects appear to be non-automatic in some studies, but automatic in others. For example, Marcel (1982) found that polysemous words were disambiguated by supraliminal context words only when the words were presented supraliminally, but not when they were presented subliminally, suggesting that subliminal word processing is not constrained by supraliminal context. In many other studies, however, context effects are automatic in one or more senses. I mention a few examples. A well-established finding in perception research is that the perceived color (e.g., green vs. yellow) of an object varies with the color of the surrounding objects (e.g., reddish vs. bluish; Purves & Lotto, 2002). This effect is fast,

compelling (i.e., uncontrolled in the promoting and the counteracting sense), and probably efficient. The same can be said about perceptual illusions such as the Müller-Lyer illusion, where the perceived length of a line depends on the orientation of the surrounding angles (>--< vs. <-->). Van Opstal, Moors, Fias, and Verguts (2008) showed that classification of a number (e.g., 4) as small or large is dependent of the range of the numbers in the stimulus set (e.g., 1-4 or 4-8). This effect even occurred when the target numbers were presented subliminally.

Conclusion

Both critics and some defenders of appraisal theory seem to struggle with a tension between the claim that appraisal is a process that causes emotions, and the proposal that appraisal is constructive, in the sense that it integrates different types of information (corresponding to stimuli, goals, expectations, coping potential, and agency/blame). Given the tacit idea that the paradigmatic cases of emotion arise quickly and unexpectedly, a process is accepted as a valid cause of emotions only when it can occur automatically. Many theorists seem to think that the constructive nature of appraisal is not reconcilable with automaticity. Some appraisal theorists have therefore abandoned the idea that appraisal is a causal process. Others have argued that appraisal is a causal process, but they have relaxed the requirement that appraisal be constructive. According to these authors, the constructive character of the appraisal process is maintained only under optimal conditions. Under suboptimal conditions, previously computed and stored appraisal outputs or emotions must be reinstated on the basis of mere stimulus input. I have argued that the compatibility of constructive processes with automaticity should be a matter of empirical research. This research need not be hindered by difficulties to distinguish between the associative and rule-based mechanisms. The core characteristic of the appraisal process is that it is constructive, which is independent of the distinction between associative and rule-based.

I discussed two sets of studies that were specifically designed to investigate the automaticity of constructive processes in appraisal. A first set of studies supported the hypothesis that integration of stimuli and goals can be automatic. Another set (of which only one study was already conducted) was concerned with the automatic integration of valence and coping potential. These studies constitute the first support in favor of the possibility that constructive appraisals can be automatic. Based on these empirical data, I propose an elaboration of process assumptions in appraisal theory. I argue that automaticity is not an exclusive feature of stimulus-based memory retrieval and that it can extend to constructive processes that integrate stimulus input and goals (and perhaps other types of information). Constructive appraisal must not be relegated to occasions in which people have abundant opportunity (time, attentional capacity, conscious stimulus input) and the intention to engage in it. It can also occur under less optimal conditions. Thus, the flexibility that comes with constructive appraisal need not disappear under suboptimal conditions. Emotions that occur under suboptimal conditions may still be adequately tuned to the motivational state of the organism, and perhaps other types of information such as coping potential and agency/blame.

Evidence for automatic constructive appraisal is necessary but not sufficient for accepting that constructive appraisal is the cause of automatically elicited emotions. Evidence for automatic constructive appraisal indicates that constructive appraisal is still a candidate cause of emotions that arise automatically, but it does not show that constructive appraisals are the actual cause of emotions, or that they can be. I confirm above that we did succeed in manipulating appraisals in our studies (at least according to my functional definition). I do not claim, however, that these appraisals were sufficient to elicit full-blown, intense emotions. As explained above, appraisal is not a sufficient cause of emotion. A stimulus must also be appraised as goal relevant, and the goal at stake must be highly important. The events of winning and not winning points may have been relevant for the goal

to win points or the goal to perform well in front of the experimenter, but it is likely that these goals were not important enough for participants to produce real emotions, at least no intense ones. Thus, our research does not demonstrate that constructive appraisals can be the cause of emotions that occur under suboptimal conditions. To demonstrate this, one must obtain evidence for (a) the presence of constructive appraisal, (b) the presence of an emotion, (c) the causal relation between "(a)" and "(b)", and (d) that the constructive appraisal occurred under suboptimal conditions. There is no current research that investigates this issue.

There have been attempts to back up the claim that appraisals can cause emotions, without specification of whether these appraisals are constructive vs. non-constructive or automatic vs. nonautomatic. Most appraisal studies try to find out which specific appraisal patterns cause which specific emotions (e.g., Roseman & Evdokas, 2004; Roseman, Antoniou, & José, 1996; Scherer, 1993b; C. A. Smith & Ellsworth, 1985, 1987). Critics have argued that several hypotheses about relations between appraisal patterns and emotions are not supported by the data (e.g., Parkinson, 2009). Moreover, they have argued that most of the evidence is based on correlational methods (e.g., self-report) that do not allow telling apart the following explanations: (a) that appraisals cause emotions, (b) that emotions cause appraisals, (c) that appraisals and emotions are caused by a third factor, (d) that appraisals are part of emotions, and (e) that appraisals and emotions are related in people's minds but not in reality (cf. Parkinson, 1997). In my opinion, incorrect hypotheses about relations between specific appraisal patterns and specific emotions should be replaced by better ones and so should methods that lack the power to demonstrate causal relations. It seems a bit too soon, however, to bury the hypothesis that (constructive and non-constructive) appraisals can and often do cause emotions, even under suboptimal conditions.

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Appendix: Glossary of Terms

Cognition: Views of cognition vary from broad to narrow (see Moors, 2007, for a taxonomy of definitions of cognition). An example of a broad view is that cognitive processes are representation-mediated. Representations intervene when stimulus-output relations are variable. Examples of variable input-output relations can be found in mere exposure effects, conditioning effects, and constructive processes (such as constructive appraisals). Examples of narrow views are that cognitive processes operate on propositional representations, that they are non-automatic, that they rely on rule-based mechanisms, that they are cortical, and that they have a cognitive (as opposed to emotional) output. Examples of cognitive outputs are gender, size, color, and location. Examples of emotional outputs are emotions, valence, and arousal.

Emotion: I distinguish between the terms emotion and emotional episode. The term emotional episode covers anything starting from the stimulus to the later components or the immediate consequences of the emotion. The notion of emotional episode is thus potentially broader than the notion of emotion. According to most emotion theories, an emotional episode is a compound of appraisal (cognitive component), subjective experience (feeling component), action tendencies (motivational component), central and peripheral physiological responses (somatic component), and expressive behavior (motor component). Emotion theories disagree about the exact number and nature of the components they include, the order in which they place them within the emotional episode (and hence the components they consider to be causes and consequences), and the component(s) that they identify as "the emotion" (cf. Moors, 2009).

Goal: The term can be used in two senses: (a) to refer to an end state in the future to which an organism is directed, and (b) to refer to a representation of that end state that drives the organism. Moreover, I use the word goal in a broad sense covering all kinds of motivational concepts such as concerns, desires, needs, drives, and standards.

Perceptual representation: A representation with a perceptual format. Perceptual representations are contrasted with propositional representations. According to some authors, perceptual representations are image-like; they have sensory or perceptual features. Some authors add motor features, calling them embodied representations. According to others, perceptual representations are those that a person entertains without ascribing truth value to them. For example, one can perceive standing on the Eiffel tower as dangerous without believing it for a fact.

Propositional representation: A representation with a propositional format. The term propositional indicates that there is a correspondence between the features of this representation and the features of propositions. According to some authors, the feature in common is that they are verbal-like (as opposed to image-like). According to others, the feature in common is that they are compositional (composed of parts that can be recombined). Still others think that the feature of interest is that propositions have truth value and that the content of a propositional representation is something to which the person ascribes truth value, something that he/she believes.

Valence: Valence is considered to be a variable (or set of variables) with minimally two values: positive and negative. The term has been used as a predicate of stimuli, feelings, action tendencies, responses, and emotions (Brosch & Moors, 2009). When used as a predicate of stimuli, valence can also be seen as the content of the representations that a person has after

appraisal of the stimulus (cf. the appraisal variables of intrinsic valence and motivational valence). This content can be said to influence the valence of feelings, action tendencies, and responses. To the extent that the latter are considered components of emotions, emotions can inherit the valence of these components and be classified as positive (e.g., happiness, pride) or negative (e.g., anger, guilt) as well. Emotions can also be classified as positive (e.g., guilt) or negative (e.g., pride) in relation to their role in social interactions and ethical norms (Solomon & Stone, 2002).

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Endnotes

[1] One could reply, however, that it is not pointless to say that adding the eggs to the dough is (part of) the cause of the cake. It should further be noted that some proponents of the first strategy have argued against the strict separation of causes and consequences within the emotional episode in general, but not against the particular proposal of appraisal as a cause of emotion. According to them, talk of cause and effect obscures the real issues that emotion theory should deal with.

[2] Several appraisal theorists leave room for a third mode of appraisal: the sensory-motor mode (Leventhal & Scherer, 1987). In this mode, performance is based on the activation of pre-wired stimulus-response connections. This mechanism is invoked to explain that certain stimuli elicit emotions without prior learning.

[3] The claim expressed in the second strategy that most appraisal theorists only provide a functional description of the appraisal process does not imply acceptance of a dual (or multi) mode theory of appraisal. On the other hand, arguing that appraisal theories have not made claims about mechanisms goes well with the view that appraisal is not dedicated to one kind of mechanism (rule-based), but that there may be several.

[4] The distinction between connectionist and dynamic systems models has been characterized in different ways. Some view connectionist models as a subclass of the dynamic systems view. Others argue that dynamic systems theory is more extreme than connectionism, because connectionism postulates the existence of subsymbolic representations whereas dynamic systems theory does away with all kinds of representations.

[5] Goal relevance and goal conduciveness might, in principle, also be delivered by a mechanism of direct memory retrieval. It is not unthinkable that certain stimuli are tagged in memory as goal (ir)relevant or goal (in)congruent as a result of prior learning. Presentation of these stimuli may trigger activation of their associated goal-(ir)relevant or goal-(in)congruent meaning.

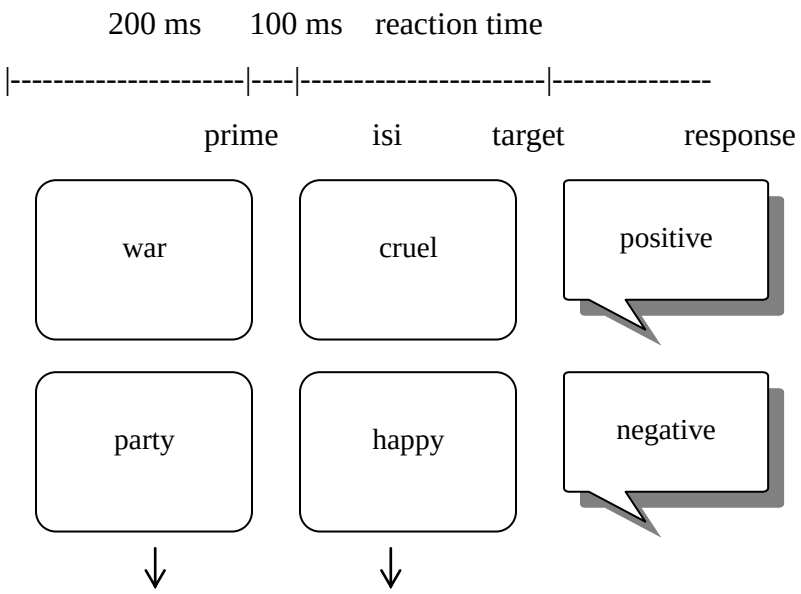
[6] In reality, the prime color was independent of the participants' key-press responses. Because of the rapid alternation of the letters during the goal-inducing phase, participants were not aware that feedback was bogus.

[7] In these articles, we used "motivational valence" as another term for "goal conduciveness".

Figure Caption

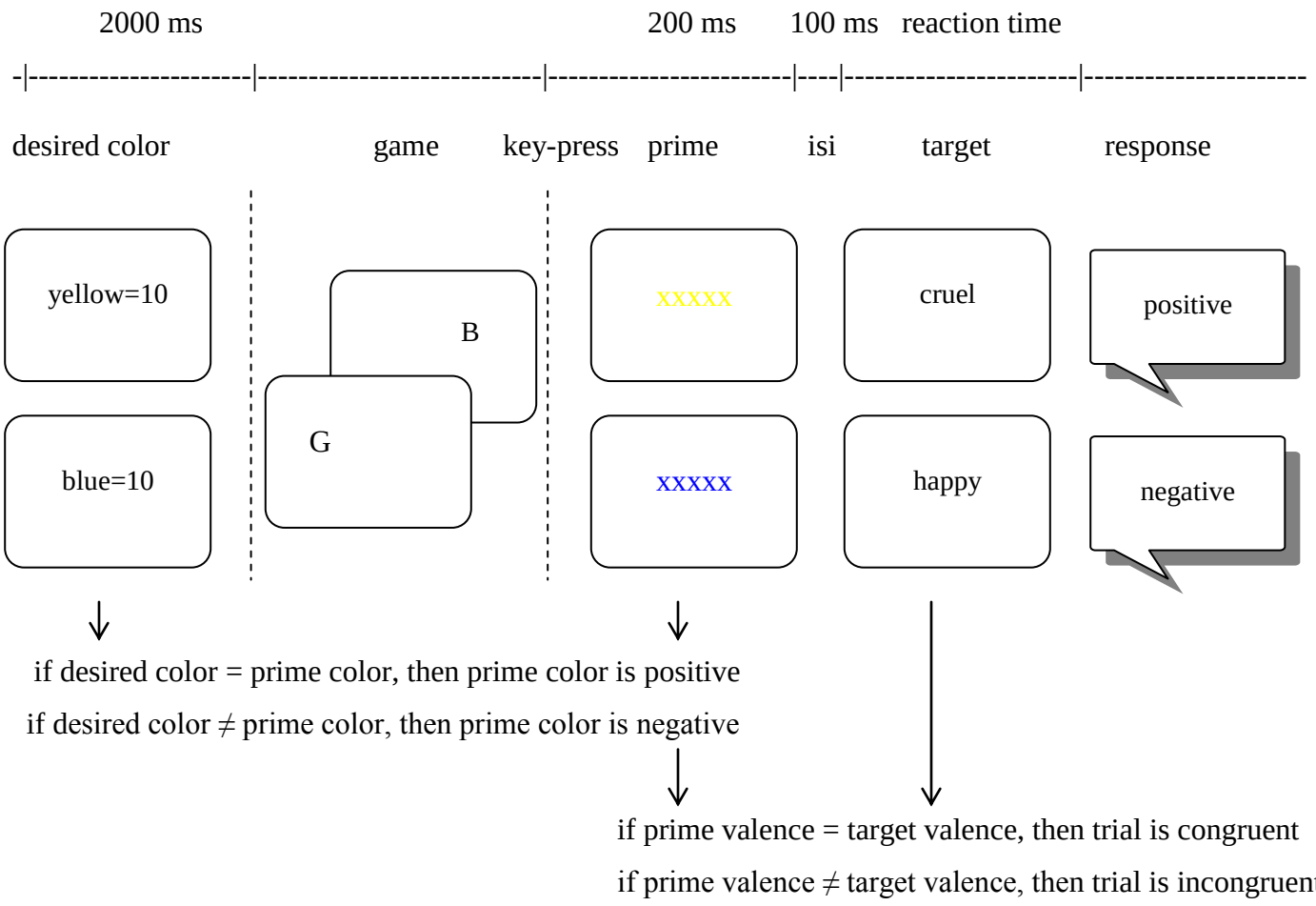
Figure 1. Possible trials in a standard affective priming task.

Figure 2. Possible trials in Experiment 1 of Moors and De Houwer (2001).



if prime valence = target valence, then trial is congruent

if prime valence ≠ target valence, then trial is incongruent


2000 ms
200 ms
100 ms
reaction time
desired color
game
key-press
prime
isi
target
response
yellow=10
blue=10
B
G
xxxxx
xxxxx
cruel
happy
positive
negative
if desired color = prime color, then prime color is positive
if desired color ≠ prime color, then prime color is negative
if prime valence = target valence, then trial is congruent
if prime valence ≠ target valence, then trial is incongruent

Box 1: Definition and Diagnosis of Automatic vs. Non-automatic Processes

Contemporary feature-based views define automaticity as an umbrella term for a number of individual features such as uncontrolled, unintentional, unconscious, efficient, and fast (Bargh, 1992; Moors & De Houwer, 2006a). These features can be defined as follows. An uncontrolled process is one that is not influenced by a person's processing goals. Processing goals can either be promoting (e.g., the goal to engage in the process) or counteracting (e.g., the goals to stop, alter, or avoid the process). A process is uncontrolled in the promoting sense when it is not caused by the goal to engage in it. Another word for uncontrolled in the promoting sense is unintentional. A process is uncontrolled in the counteracting sense when it is not counteracted (stopped, altered, or avoided) by the goal to do so (stop, alter, or avoid). A process is unconscious when the person has no awareness of it. It may be noted that an unconscious process can operate on a conscious or an unconscious input. An efficient (also called effortless) process is one that makes minimal use of attentional capacity. Finally, a fast process is one that is completed within a short amount of time.

These definitions of automaticity features can be reformulated in terms of operating conditions. For example, a process is uncontrolled in the promoting sense (unintentional) when the goal to engage in it is not (or only a redundant) part of the set of conditions that is sufficient for the process to operate. A process is uncontrolled in the counteracting sense when it operates in the absence of, or despite the presence of, the goal to counteract the process. A process (or the input to a process) is unconscious when it operates under the condition of a lack of awareness of the process (or of the input). A process is efficient when it operates under the condition of minimal attentional capacity. A process is fast when it can be completed under the condition of minimal time. In short, a process is automatic when it operates under suboptimal conditions (such as when there is minimal time, minimal attentional capacity, no conscious input, and/or no intention to engage in the process);

a process is non-automatic when it operates only under optimal conditions (such as when there is abundant time, abundant attentional capacity, conscious input, and/or the intention to engage in the process).

In addition to a feature-based view of automaticity, contemporary investigators favor a gradual view of automaticity (Moors & De Houwer, 2006a, 2007; Shiffrin, 1988). This gradualness is manifested in two ways. First, a process can be automatic with regard to some but not other features. This means that it may occur under a mix of optimal and suboptimal conditions (Bargh, 1992). For example, a process may be both unintentional and nonefficient. Second, each automaticity feature can itself be considered as gradual. Time and attentional capacity can be more or less available; processes (or stimulus input) can be more or less conscious (if a gradual view of consciousness is endorsed); goals to engage in or counteract a process can be achieved to a more or less extent. Although a gradual view of automaticity is theoretically the most cautious approach, it does not provide an empirical criterion to separate automatic processes from non-automatic ones. This problem can be met by making only relative conclusions about automaticity. This means specifying the features of automaticity that apply and choosing a subjective criterion as a standard for comparison. For example, a process may be more efficient than another process, more efficient than before practice, or more efficient than what is generally expected. Another example of a subjective criterion can be found in the research literature on visual search tasks (e.g., an angry face is shown amidst neutral faces and set size is manipulated). Processing of the target (e.g., angry face) is called efficient when an increase in set size does not lead to an increase in reaction times, and it is agreed that this is the case when the slope is below 10 ms (Horstmann, 2007).

Box 2: Definition and Diagnosis of Rule-based vs. Associative Mechanisms

As stated above, the distinction between associative and rule-based can be situated on the algorithmic level of process description. In a rule-based mechanism, a mental rule is applied to an input (or a representation thereof) and computation of the rule produces an output. In an associative mechanism, an input activates stored representations of similar past inputs. This activation, in turn, spreads to associated stored representations, which determine the output. As an example, consider that an output of positive or negative valence can be determined either by comparing the stimulus with the person's current goal, or by activating a previously associated valence tag in memory. Despite the fact that both mechanisms seem intuitively very different, it is notoriously difficult to find a formal criterion that captures the distinction between them. This, in turn, complicates the task of developing an empirical criterion to separate the associative mechanism from rule-based ones. Such an empirical criterion is essential if one is dedicated to investigating whether rule-based mechanisms can operate automatically.

I briefly discuss some of the criteria that have been proposed in the literature and explain why they are invalid or why they do not lead to empirical criteria (for a more elaborate review of criteria, see discussions by Hahn & Chater, 1998; Moors & De Houwer, 2006b). One criterion is that rule-based mechanisms can be described by IF-THEN rules (Kruglanski, Erb, Pierro, Mannetti, & Chun, 2006). As an example, consider the rule that might be required for the computation of goal conduciveness: "IF S = G THEN positive ELSE negative", with S standing for stimulus (or actual state) and G standing for goal (or desired state). The criterion that only rule-based mechanisms can be described by IF-THEN rules is easily dismissed by pointing out that the associative mechanism can also be described by an IF-THEN rule (Hahn & Chater, 1998; Sloman, 1996). For example, "IF chocolate cake THEN positive".

A second criterion is that rule-based mechanisms but not associative ones can be described by abstract rules (e.g., Sloman, 1996; E. E. Smith, Langston, & Nisbett, 1992) in which the premise (the IF-part) contains variables. Variables are abstract representations that can be instantiated in more than one way (i.e., with more than one constant). In the abstract rule "IF S = G THEN positive ELSE negative", the variables S and G can be instantiated with an infinite range of stimuli and goals. Associations fit the format of non-abstract rules in which the premise contains only constants. Constants are representations of concrete or even unique instances. In the non-abstract rule "IF chocolate cake THEN positive", the constant "chocolate cake" cannot be instantiated by other stimuli. Based on the second criterion one might be inclined to say that abstract rules but not non-abstract rules allow for generalization toward novel stimuli. This is no longer true, however, when the second criterion is supplemented with a third criterion.

The third criterion spells out that rule-based mechanisms can operate only when there is a perfect match between the input and the premise, whereas the associative mechanism can also operate when there is a partial match between input and premise or stored representation (Hahn & Chater, 1998). The abstract rule "IF S = G THEN positive ELSE negative" cannot be computed unless a value for S and G is available. The non-abstract rule "IF chocolate cake THEN positive" can be applied to any stimulus that bears some similarity with the chocolate cake figuring in the premise (the more similarity, the stronger activation of the memory trace will be).

Due to the complementary forces of abstraction and partial matching, both the associative mechanism and rule-based ones can account for generalization toward new stimuli. In the case of rule-based mechanisms, generalization is obtained by virtue of abstract variables; in the case of the associative mechanism, generalization is obtained by virtue of partial matching. It may further be noted that abstraction is a gradual notion (Hahn & Chater, 1998; Pothos, 2005). The variables

figuring in abstract rules and the constants figuring in non-abstract rules occupy two points on a continuum. Variables can be substituted by a larger class of instances than constants can, but the variables that figure in abstract rules often cannot be substituted by just any constant. For instance, in the abstract rule "IF S = G THEN positive ELSE negative", S and G must be instantiated by a stimulus and a goal, not by just anything. Conversely, constants often hold some level of abstraction. For instance, in the non-abstract rule "IF chocolate cake THEN positive", the representation of chocolate cake can be instantiated by more than one unique chocolate cake. The fact that no objective line can be drawn between variables and constants is reflected in the idea that activation of stored knowledge can be based on concrete as well as abstract similarities (cf. Goldstone, 1994; Hummel & Holyoak, 2003; Redington & Chater, 1996). Thus, evidence for generalization toward stimuli that share abstract (but not concrete) features with previously acquired ones (Marcus, Vijayan, Bandi Rao, & Vishton, 1999; Reber, 1989) is equally compatible with rule-based as with associative accounts (Redington & Chater, 1996; but see E. E. Smith et al., 1996; Sloman & Rips, 1998).